

Claims:

1.

1 A method of making a plastic closure that comprises the steps of:

2 (a) providing a plastic cap that includes a base and a peripheral skirt defining
3 a cap interior,

4 (b) placing within said cap interior, on said base, a mold charge that includes
5 layers of matrix polymer material alternating with layers of barrier polymer material to resist
6 transmission of gases, water vapor or flavorants, and compatibilizer material comprising a
7 thermoplastic resin for tying the matrix polymer material to the barrier polymer material by
8 reactive bonds or non-reactive adhesion mechanisms, and

9 (c) compression molding said mold charge in situ within said cap interior
10 against said base to form a liner on said base having layers of barrier polymer material alternating
11 with layers of matrix polymer material.

2.

1 The method set forth in claim 1 wherein said step (b) comprises orienting said
2 mold charge so that said layers are at a predetermined orientation with respect to said base.

3.

1 The method set forth in claim 1 wherein said step (b) is such that said layers in
2 said mold charge are at random orientation with respect to said base.

4.

1 The method set forth in claim 1 further comprising, prior to said step (b):
2 (d) extruding mold charge material having said layers therein, and
3 (e) severing said mold charge from the material extruded in said step (d).

5.

1 The method set forth in claim 1 wherein said compatibilizer material is disposed
2 in said matrix polymer material layers, or in said barrier polymer material layers, or in separate
3 layers between said matrix polymer material and barrier polymer material layers.

6.

1 The method set forth in claim 1 wherein said mold charge consists essentially of
2 said matrix polymer material, said barrier polymer material and said compatibilizer material.

7.

1 The method set forth in claim 6 wherein said barrier polymer material includes
2 platelets of smectite clay.

8.

1 The method set forth in claim 1 wherein said matrix polymer material is selected
2 from the group consisting of thermoplastic elastomers, soft olefin polymers, and mixtures
3 thereof.

9.

1 The method set forth in claim 8 wherein said matrix polymer material is a
2 thermoplastic elastomer having a Shore A hardness of 45 to 95 and a flexural modulus of 30,000
3 to 100,000 psi.

10.

1 The method set forth in claim 8 wherein said matrix polymer material comprises
2 at least one thermoplastic elastomer selected from the group consisting of styrene block
3 copolymers and elastomeric alloys.

11.

1 The method set forth in claim 10 wherein said matrix polymer material is an olefin
2 polymer having a Shore A hardness less than 100.

12.

1 The method set forth in claim 11 wherein said olefin polymer is selected from the
2 group consisting of metallocene-made polyethylene, ethylene-propylene rubbers, ethylene
3 copolymers, and mixtures thereof.

13.

1 The method set forth in claim 1 wherein said barrier polymer material is selected
2 from the group consisting of EVOH, crystalline, semi-crystalline and amorphous nylons,
3 acrylonitrile copolymers, blends of EVOH and amorphous nylon, nanocomposites of EVOH or
4 nylon and clay, blends of EVOH and an ionomer, acrylonitrile, cyclic olefin copolymers, and
5 blends thereof.

14.

1 The method set forth in claim 1 wherein said compatibilizer material is selected
2 from the group consisting of maleic anhydride grafted polymers, ethylene vinyl acetate grafted
3 polymers, ethylene methyl acrylate, ionomers and blends thereof.

15.

1 The method set forth in claim 1 wherein said barrier polymer material comprises
2 EVOH or nylon, and said matrix polymer material comprises EVA.

16.

1 The method set forth in claim 1 wherein said matrix polymer material consists
2 essentially of a blend of one or more matrix polymers and said compatibilizer material.

17.

1 The method set forth in claim 1 wherein said mold charge consists of at least nine
2 alternating layers of said matrix polymer and barrier polymer materials.

18.

1 The method set forth in claim 17 wherein said liner consists of at least thirty-three
2 alternating layers of said matrix polymer and barrier polymer materials.

19.

1 The method set forth in claim 18 wherein said liner consists of at least one
2 hundred twenty-nine alternating layers of said matrix polymer and barrier polymer materials.

20.

1 The method set forth in claim 1 wherein said liner has a Shore A hardness of not
2 more than 94.

21.

1 The method set forth in claim 1 wherein mold charge contains lubricant selected
2 from the group consisting of fatty acid amides, fatty acid esters, microcrystalline waxes,
3 polyethylene glycols, primary amides, secondary amides, secondary-bis amides, and blends
4 thereof.

22.

1 The method set forth in claim 21 wherein said lubricant is in the amount of about
2 0.5% to 1.5% by weight of said mold charge.

23.

1 The method set forth in 22 wherein said lubricant is in the amount of about 0.5%
2 by weight of said mold charge.

24.

1 A method of making a plastic closure that comprises the steps of:

2 (a) extruding plastic mold charge material that consists essentially of: (1)
3 continuous layers of matrix polymer material alternating with continuous layers of barrier
4 polymer material to resist transmission of gases, water vapor or flavorants, totaling at least nine
5 alternating layers of matrix and barrier polymer materials, and (2) compatibilizer material
6 comprising thermoplastic resin for tying the layers of matrix polymer material to the layers of
7 barrier polymer material by reactive bonds or non-reactive adhesion mechanisms, said
8 compatibilizer material being disposed in said matrix polymer material layers, or in said barrier
9 polymer material layers, or in separate layers between the matrix and barrier polymer material
10 layers,

11 (b) severing a mold charge pellet from the mold charge material extruded in
12 said step (a),

13 (c) providing a plastic cap that includes a base and a peripheral skirt defining
14 a cap interior,
15 (d) placing said mold charge pellet within said cap, and then
16 (e) compression molding said mold charge pellet in situ within said cap
17 against said base to form a liner on said base having continuous layers of barrier polymer material
18 alternating with continuous layers of matrix polymer material.

25.

1 The method set forth in claim 24 wherein said matrix polymer material is selected
2 from the group consisting of thermoplastic elastomers, soft olefin polymers, and mixtures
3 thereof.

26.

1 The method set forth in claim 26 wherein said matrix polymer material comprises
2 at least one thermoplastic elastomer selected from the group consisting of styrene block
3 copolymers and elastomeric alloys.

27.

1 The method set forth in claim 26 wherein said olefin polymer is selected from
2 the group consisting of metallocene-made polyethylene, ethylene-propylene rubbers, ethylene
3 copolymers, and mixtures thereof.

28.

1 The method set forth in claim 24 wherein said barrier polymer material is selected
2 from the group consisting of EVOH, crystalline, semi-crystalline and amorphous nylons,
3 acrylonitrile copolymers, blends of EVOH and amorphous nylon, nanocomposites of EVOH or
4 nylon and clay, blends of EVOH and an ionomer, acrylonitrile, cyclic olefin copolymers, and
5 blends thereof.

29.

1 The method set forth in claim 24 wherein said barrier polymer material includes
2 platelets of smectite clay.

30.

1 The method set forth in claim 24 wherein said compatibilizer material is selected
2 from the group consisting of maleic anhydride grafted polymers, ethylene vinyl acetate grafted
3 polymers, ethylene methyl acrylate, ionomers and blends thereof.

31.

1 The method set forth in claim 24 wherein said mold charge material includes a
2 lubricant selected from the group consisting of fatty acid amides, fatty acid esters,
3 microcrystalline waxes, polyethylene glycols, primary amides, secondary amides, secondary-bis
4 amides, and blends thereof.

32.

- 1 A method of making a liner for a plastic closure that comprises the steps of:
- 2 (a) extruding a pellet that consists essentially of a multiplicity of alternating
- 3 layers of matrix polymer material and barrier polymer material that resists gas transmission, and
- 4 (b) compression molding said pellet to form a liner disk in which the
- 5 alternating material layers are oriented generally parallel to the disk.

33.

- 1 The method set forth in claim 32 wherein said matrix polymer material consists
- 2 essentially of a blend of one or more matrix polymers and a compatibilizer material.

34.

- 1 The method set forth in claim 33 wherein the blend of matrix polymer and
- 2 compatibilizer materials differs in melt viscosity from said barrier polymer material by no more
- 3 than a factor of five.

35.

- 1 The method set forth in claim 32 wherein said step (a) includes the step of
- 2 extruding a compatibilizer material with said matrix and barrier polymer materials.

36.

1 The method set forth in claim 35 wherein said compatibilizer material is blended
2 with one or both of said matrix and barrier polymer materials prior to extrusion.

37.

1 The method set forth in claim 35 wherein said matrix polymer material, said
2 barrier polymer material and said compatibilizer material are extruded as separate layers.

38.

1 The method set forth in claim 37 wherein layers of barrier polymer material and
2 matrix polymer material alternate with each other, and wherein a layer of said compatibilizer
3 material is disposed between each layer of barrier polymer material and each layer of matrix
4 polymer material.

39.

1 The method set forth in claim 35 wherein said barrier polymer material is in the
2 range of about 6% to 35% by weight in said pellet, said compatibilizer material is in the range
3 of about 6% to 20% by weight, the balance consisting of said matrix polymer material.

40.

1 The method set forth in claim 32 wherein said matrix polymer material is selected
2 from the group consisting of thermoplastic elastomers, soft olefin polymers, and mixtures
3 thereof.

4

41.

1 The method set forth in claim 40 wherein said matrix polymer material is a
2 thermoplastic elastomer having a Shore A hardness of 45 to 95 and a flexural modulus of 30,000
3 to 100,000 psi.

42.

1 The method set forth in claim 40 wherein said matrix polymer material comprises
2 at least one thermoplastic elastomer selected from the group consisting of styrene block
3 copolymers and elastomeric alloys.

43.

1 The method set forth in claim 40 wherein said matrix polymer material is an olefin
2 polymer having a Shore A hardness less than 100.

44.

1 The method set forth in claim 43 wherein said olefin polymer is selected from the
2 group consisting of metallocene polyethylene, ethylene-propylene rubbers, ethylene copolymers,
3 and mixtures thereof.

45.

1 The method set forth in claim 32 wherein said barrier polymer material is selected
2 from the group consisting of EVOH, crystalline, semi-crystalline and amorphous nylons,
3 acrylonitrile copolymers, blends of EVOH and amorphous nylon, nanocomposites of EVOH or
4 nylon with clay, blends of EVOH and an ionomer, acrylonitrile, cyclic olefin copolymers, and
5 blends thereof.

46.

1 The method set forth in claim 32 wherein said pellet further includes a
2 compatibilizer material comprising thermoplastic resin for tying the matrix polymer material to
3 the barrier polymer material by reactive bonds or non-reactive adhesion mechanisms, with said
4 compatibilizer material being selected from the group consisting of maleic anhydride grafted
5 polymers, ethylene vinyl acetate grafted polymers, EVA, ethylene methyl acrylate, ionomers and
6 blends thereof.

47.

1 The method set forth in claim 32 wherein said liner consists of at least nine
2 alternating layers of said matrix and barrier polymer materials.

48.

1 The method set forth in claim 47 wherein said liner consists of at least thirty-three
alternating layers of matrix and barrier polymer materials.

49.

1 The method set forth in claim 48 wherein said liner consists of at least one
2 hundred twenty-nine alternating layers of matrix and barrier polymer materials.

50.

1 The method set forth in claim 32 that comprises the additional step of:
2 (c) providing a closure cap having a base and a peripheral skirt defining a cap
3 interior and means on said skirt for securing the cap to a container, and
4 (d) securing said liner disk to the interior of said base.

51.

1 The method set forth in claim 50 wherein said steps (b) and (d) are carried out
2 simultaneously by compression molding said pellet in situ on the interior of said base.

52.

1 The method set forth in claim 32 wherein said liner has a Shore A hardness of not
2 greater than 94.

53.

1 The method set forth in claim 52 wherein said liner contains a lubricant selected
2 from the group consisting of fatty acid amides, fatty acid esters, microcrystalline waxes,
3 polyethylene glycols, primary amides, secondary amides, secondary-bis amides, and blends
4 thereof.

54.

1 The method set forth in claim 53 wherein said lubricant is in the amount of about
2 0.5% to 1.5% by weight of said liner.

55.

1 The method set forth in claim 54 wherein said lubricant is in the amount of about
2 0.5% by weight of said liner.